

Modified Enlarged 18 pt

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Thursday 14 January 2021 – Morning

Level 3 Cambridge Technical in Applied Science

05847/05848/05849/05874/05879

Unit 2: Laboratory techniques

Time allowed: 2 hours plus your additional time allowance

You must have:

the Data Sheet

a ruler (cm/mm)

copy of the Periodic Table

You can use:

a scientific or graphical calculator

an HB pencil

Please write clearly in black ink.

**Centre
number**

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**Candidate
number**

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First name(s)

Last name

Date of birth

D	D	M	M	Y	Y	Y	Y
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READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

Answer ALL the questions.

INFORMATION

The total mark for this paper is 90.

The marks for each question are shown in brackets [].

The Periodic Table is supplied separately.

ADVICE

Read each question carefully before you start your answer.

Answer ALL the questions.

1 Jane is a technician working in a laboratory.

Jane carries out an experiment to find out how much a thin wire stretches when she adds increasing loads (weights) to the wire. She wants to see if the extension of the wire is directly proportional to the load.

(a) She records the results of the experiment and notes her name and the date that the work is done.

Suggest why Jane's name and the date were recorded.

[1]

(b) TABLE 1.1 shows Jane's results.

TABLE 1.1

Load added / N	Length / mm	Extension of the wire
0	30	0
500	35	5
1000	40	10

Jane forgets to record a key detail in one of the column headings in TABLE 1.1.

State the key detail that is missing.

[1]

- (c) (i) Describe TWO ways the data collected can be improved to make the results of the experiment more reliable.**

1

2

[2]

- (ii) Design a table of results that would allow the data from the improved experiment to be collected. Use the space below. [4]**

- (d) (i) Jane produces a risk assessment, before completing the experiment.**

Describe ONE hazard that the experiment might present.

[1]

- (ii) State ONE precaution that Jane should take to reduce the risk of the hazard identified in (d)(i).**

[1]

- (e) All new employees in the laboratory must be trained in health and safety.**

Suggest why it is important that all new employees are trained in health and safety.

[1]

- (f) Amir is another technician working in the laboratory. He is using a pH meter to measure the pH of some acidic solutions. Before he uses the pH meter it must be calibrated.

Outline **FOUR** of the steps involved in the calibration of a pH meter.

1

2

3

4

[4]

- 2 HPLC can be used to separate the component compounds in a mixture.**

FIG 2.1 opposite shows a chromatogram of a mixture separated by HPLC.

Retention times for four of the compounds are shown in TABLE 2.1.

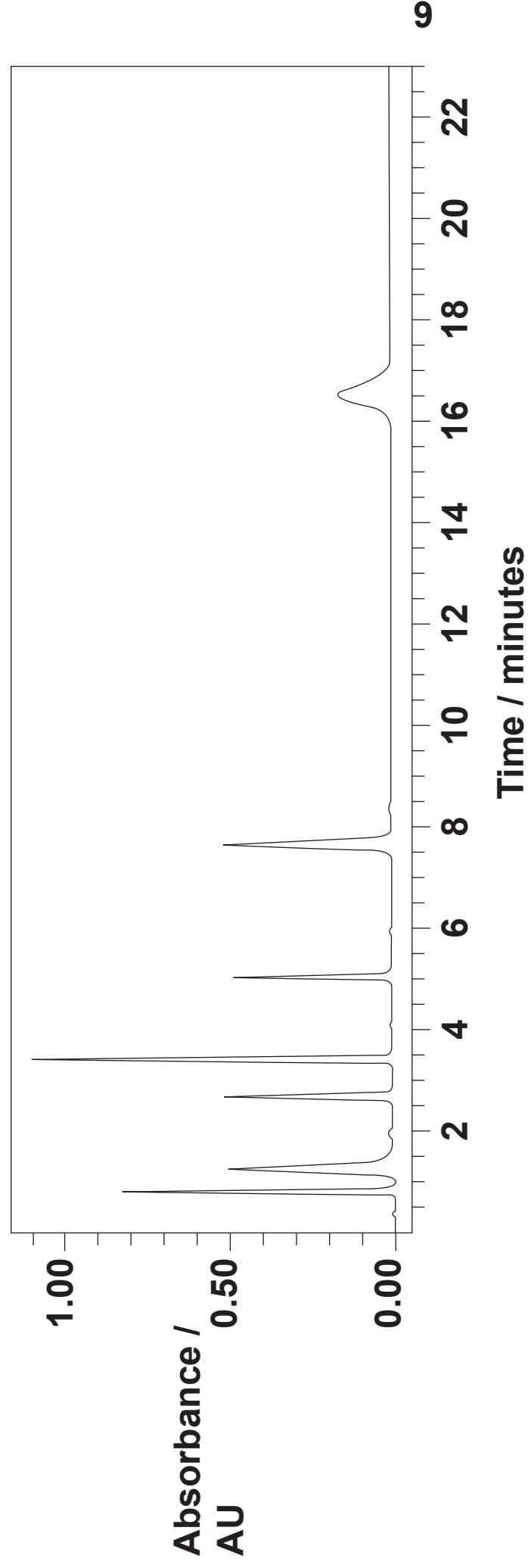
TABLE 2.1

Compound number	Compound name	Retention time
1	Paracetamol	1 minute 20 seconds
2	Theobromine	3 minutes 30 seconds
3	Theophylline	5 minutes
4	Caffeine	7 minutes 40 seconds

- (a) Identify four peaks in FIG 2.1 that match the compounds listed in TABLE 2.1.**

Write the compound number immediately above each correct peak in FIG 2.1 opposite. [3]

FIG 2.1



- (b) (i) In TABLE 2.2 put a TICK (✓) against the THREE correct advantages of linking HPLC to a mass spectrometer. [3]

TABLE 2.2

Advantage	Tick
Positive identification of unknown chemicals	
Technicians need less training	
Reduced cost	
Quantification of known compounds	
Reduces the time taken to separate the molecules	
Provides information on structure of compounds	

- (ii) Complete the sentences to explain the features of mass spectroscopy.

Use words from the list.

You can use each word once, more than once, or not at all.

electrons

gas

gravitational

liquid

magnetic

solid

The sample eluted from an HPLC column is converted into a _____.

The compounds in the sample have _____ removed to form positive ions.

A _____ field is then used to separate the ions according to their mass : charge ratio. [3]

- (c) Explain how thin layer chromatography (TLC) can be used to separate and identify chemicals present in samples.**

Your answer should include:

How TLC is set up.

How TLC separates different chemicals.

How to identify chemicals on a TLC plate by calculating R_f values.

You may include a diagram in your answer.

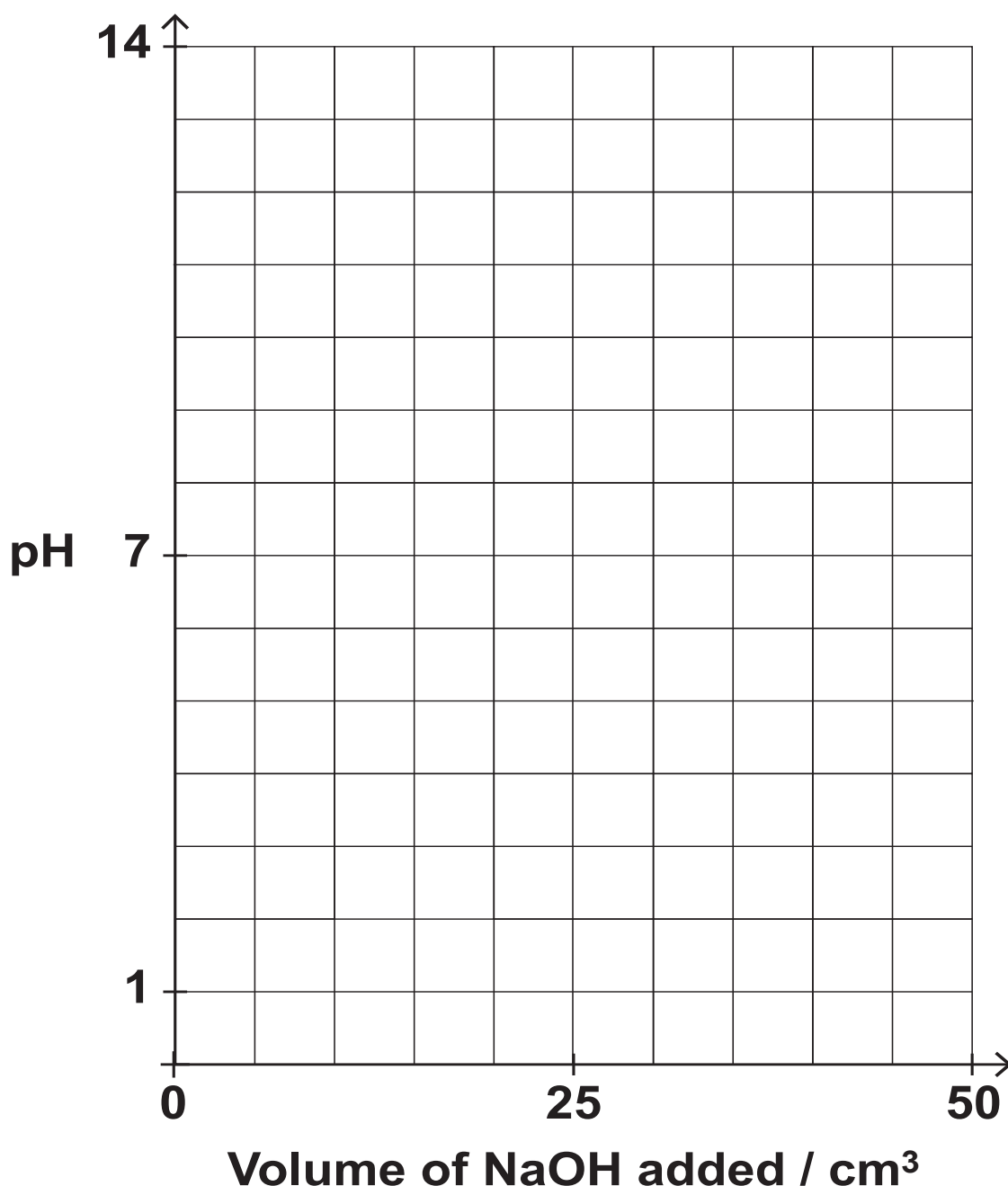
Use the space below for the diagram. [6]

3 Titrations can be used to determine the concentration of acids or bases.

- (a) 50 cm^3 of 0.1 mol dm^{-3} sodium hydroxide, NaOH, is gradually added to 25 cm^3 of 0.1 mol dm^{-3} hydrochloric acid, HCl. The pH is plotted against the volume of NaOH added.

On the axes in FIG 3.1 sketch the shape of the titration curve and label the equivalence point.
[3]

FIG 3.1



(b) FIG 3.2a shows the reading on a burette at the start of a titration.

FIG 3.2b shows the reading at the end-point of a titration.

FIG 3.2a

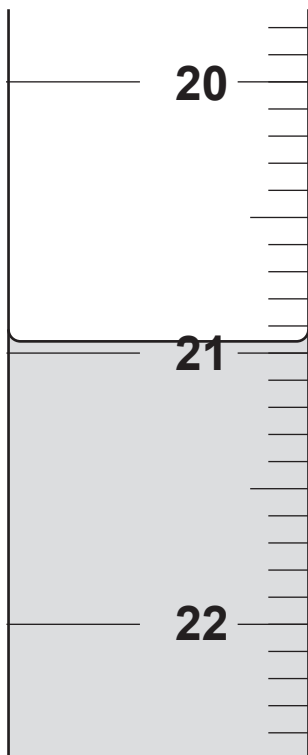
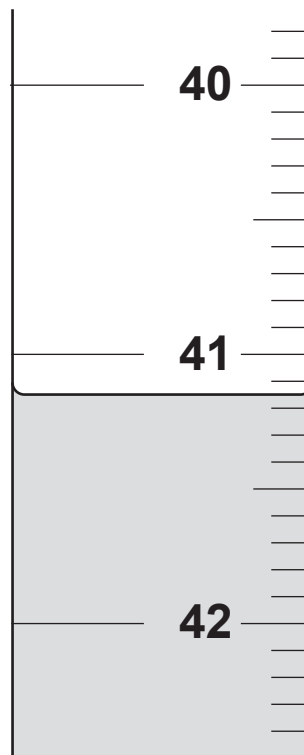


FIG 3.2b



(i) State TWO precautions that should be taken to ensure the burette reading is accurate.

1

2

[2]

(ii) Calculate the volume of titrant added.

Give your answer to an APPROPRIATE
NUMBER of significant figures.

Show your working.

Volume of titrant added = _____ cm³
[2]

(iii) This titration was repeated. The other two titres
were 20.10 cm³ and 20.15 cm³.

Calculate the mean volume of titrant added.

Mean volume of titrant added = _____ cm³
[1]

(c) Mia is a science student.

She completes a titration to determine the concentration of an aqueous solution of calcium hydroxide, Ca(OH)_2 (aq).

Mia finds that 19.50 cm^3 of $0.0200 \text{ mol dm}^{-3}$ hydrochloric acid (HCl) is required to neutralise 25.00 cm^3 of the calcium hydroxide solution.

In this reaction, TWO moles of HCl are needed to neutralise ONE mole of Ca(OH)_2 .

Mia knows that she must use the following relationship in her calculations:

$$\text{number of moles} = \frac{\text{concentration in mol dm}^{-3} \times \text{volume in cm}^3}{1000}$$

(i) Calculate the number of moles of HCl required to neutralise the Ca(OH)_2 solution.

Number of moles of HCl = _____ mol
[1]

- (ii) Use the reacting ratio to calculate the number of moles of Ca(OH)_2 in 25.00 cm^3 of the calcium hydroxide solution.

Number of moles of $\text{Ca(OH)}_2 =$ _____ mol
[1]

- (iii) Calculate the concentration, in mol dm^{-3} , of the calcium hydroxide solution.

Concentration of $\text{Ca(OH)}_2 =$ _____ mol dm^{-3}
[1]

- (d) An auto-titrator is frequently used in the food industry to determine the acidity of fruit juice. Complete the sentences about auto-titration. Use words from the list.

You can use each word once, more than once, or not at all.

electrode

endpoint

large

meter

temperature

small

volume

Auto-titrators use an _____
to determine the _____
for acid base titrations.

They are programmed to add _____
quantities of titrant in the region of the
_____ so that the
_____ of titrant needed for
neutralisation can be accurately determined. [4]

- 4 Kai is a technician working in a hospital laboratory. He uses different types of microscope to view objects too small to see with the naked eye.**

(a) Complete the sentences about microscopy.

Use words from the list.

You can use each word once, more than once, or not at all.

accuracy

electron

graticule

light

resolution

ruler

size matrix

Living cells can be viewed using

_____ microscopy.

Electron microscopy has a higher

_____ than light

microscopy.

A _____ can be used to

measure the size of an object when viewed by light

microscopy. [3]

- (b) Kai is preparing to use a light microscope to view blood cells.

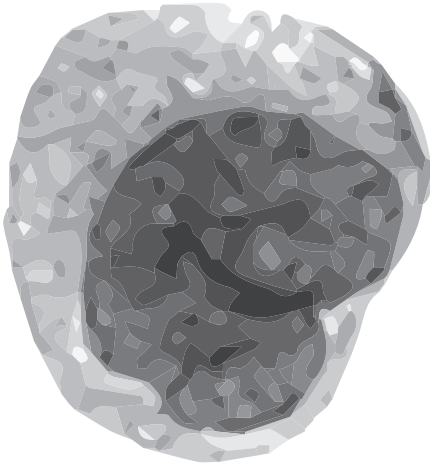
Outline **FOUR** of the steps that Kai should take to safely focus the blood cells with the greatest magnification.

- 1 _____
- 2 _____
- 3 _____
- 4 _____

[4]

- (c) FIG 4.1 shows the image that Kai can see of a sample of blood using his light microscope.

FIG 4.1



White blood cell

- (i) In the space below make a **LARGE** scientific line drawing of the **WHITE BLOOD CELL** as seen by Kai in FIG 4.1. [3]

- (ii) Use a ruler to measure the diameter of the white blood cell in FIG 4.1 at the widest part, to the nearest mm.

Width of white blood cell = _____ mm
[1]

- (iii) The actual size of the white blood cell is 1.5×10^{-2} mm.

Calculate the magnification used to view the white blood cell in FIG 4.1.

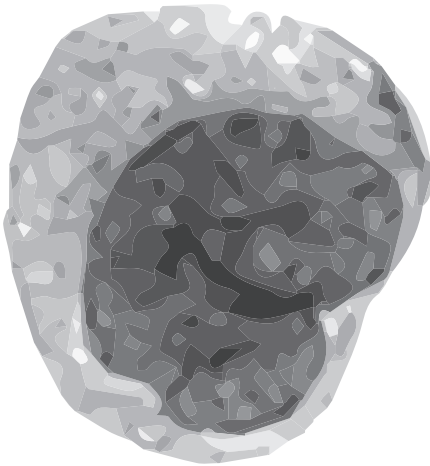
Use the formula:

magnification = measured size \div actual size

Show your working.

Magnification = \times _____
[1]

FIG 4.1 is repeated below.



White blood cell

- (iv) The eyepiece lens has a magnification of $\times 10$.**

Calculate the magnification of the objective lens.

Magnification = \times _____

[1]

- (v) Kai viewed the white blood cell using a $\times 10$ objective lens and a $\times 10$ eyepiece lens.

He changes the objective lens for one with a magnification of $\times 40$. The eyepiece lens remains the same.

Calculate the size that the white blood cell will appear when viewed using the microscope with the $\times 40$ objective lens.

Size of white blood cell = _____ mm
[2]

5 A student is using chemical testing to identify anions.

- (a) (i) The student is asked to consider different tests and the results expected for three anions.**

For EACH of the anions listed in FIG 5.1 opposite, draw a line to link it to the correct test. Then draw a line to link each test to the POSITIVE RESULT expected. [5]

- (ii) One of the positive results in FIG 5.1 produced bubbles of carbon dioxide.**

Describe the test for the presence of carbon dioxide AND the positive result.

Test _____

Positive result _____

[2]

- (iii) Name TWO other anions that can be tested for by adding a few drops of nitric acid followed by silver nitrate.**

1 _____

2 _____

[1]

FIG 5.1

Anion	Test	Positive result
Carbonate	Add a few drops of nitric acid then a few drops of silver nitrate	White precipitate produced
Bromide	Add a few drops of hydrochloric acid and then a few drops of barium chloride solution	Cream precipitate produced
Sulfate	Add a few drops of acid	Bubbles produced

(iv) Explain why nitric acid is added first when testing for halides.

[2]

(b) (i) The student finds out that flame tests and ICP-AES can both be used to identify metal ions.

Give the full name for AES.

[1]

(ii) **TABLE 5.1** lists some features of flame tests and ICP-AES for metal ions.

Put a tick (✓) in the correct box in each row to show if the feature is found in a **FLAME TEST** or in **ICP-AES**. [4]

TABLE 5.1

Feature	Flame test	ICP-AES
Quantitative analysis		
Cheap and easy to do		
High levels of sensitivity		
Requires high level of training		
Can be done outside of the laboratory		
Can detect multiple metals in the same sample		

- 6 A biological research company focuses on the growth of microorganisms in a laboratory.**

One of the sources for testing microorganisms is river water.

The scientists in the laboratory must make sure that the materials and equipment they use are sterile.

- (a) For each item in TABLE 6.1 opposite put a tick (✓) for the most appropriate way to sterilise it. [6]**

TABLE 6.1

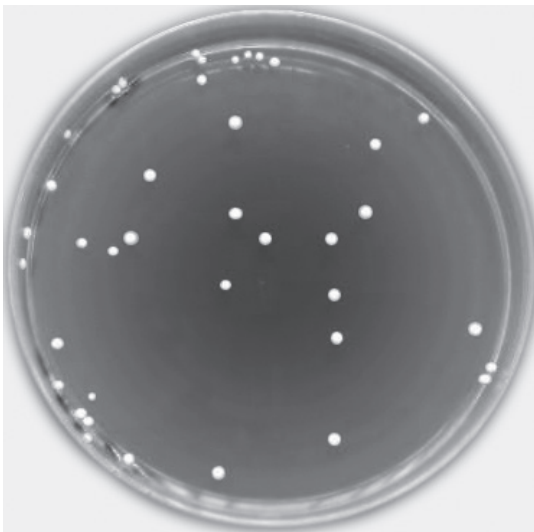
Item	Autoclave	Spray with ethanol solution	Filter	Open flame	Dry heat
Bacterial growth medium					
Inoculating loop					
Antibiotic solutions					
Empty glassware					
Open bottle of sterile diluting water					
Inside of controlled air flow cabinets					

- (b) The research scientists grow microorganisms on agar plates.

They find that this is a useful way to assess the purity and number of microorganisms present in a sample.

FIG 6.1 shows a plate of yeast colonies.

FIG 6.1



State how the plate in FIG 6.1 shows that the yeast culture is NOT contaminated with other microorganisms.

[1]

- (c) The plate in FIG 6.1 was produced by the spread plating method as follows:

A yeast culture was grown in liquid growth medium.

10 cm³ of culture was diluted with sterile water to make a final volume of 1000 cm³.

0.1 cm³ of the dilution was then spread onto the sterile plate.

The plate was then incubated for 24 hours to allow the yeast to grow.

- (i) Count the number of yeast colonies growing from the 0.1 cm³ spread.

Number of yeast colonies on plate = _____ [1]

- (ii) Calculate the number of yeast colonies in the initial 10 cm³ of the undiluted culture.

Number of yeast colonies in 10 cm³ of undiluted culture = _____ [2]

- (iii) Explain why spread plating the **UNDILUTED** yeast culture would not have been useful to work out the number of yeast colonies in the culture.

[1]

- (d) The research scientists grew microorganisms from a sample of river water on an agar plate. The plate is shown in FIG 6.2.

FIG 6.2



- (i) Estimate how many DIFFERENT types of microorganism were growing in the river water.

Explain your answer.

[2]

- (ii) State TWO reasons why it is important to maintain aseptic techniques when analysing microorganisms in river water.

1

2

[2]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question numbers must be clearly shown in the margins – for example, 2(c) or 6(b)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no text or other markings on the paper.



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